HERITABILITY OF MATING BEHAVIOUR TRAITS IN BEEF BULLS

C.M. Wade[1], J.D. Bertram[2] B. Pullen[1] and V. Perry[1]

[1]School of Veterinary Science, The University of Queensland, QLD 4072
[2]Department of Primary Industries, Goondiwindi, QLD 4390

SUMMARY

Libido measurements were obtained from 648 bulls of three breeds (Santa Gertrudis [251], Belmont Red [208] and Hereford [189]) on six properties using a twenty-minute serving capacity test. Measurements that were taken included MOUNTS and SERVES. Data were analysed for each measure plus MOUNTS+SERVES using models incorporating the fixed effects of breed and property-year, with age in days and weight at time of test used as covariables. Heritabilities were analysed using an animal model and Restricted Maximum Likelihood procedures (ASREML). Significant heritabilities were observed for MOUNTS (0.29±0.14 and 0.57±0.25) in across breed and Santa Gertrudis analyses respectively. Non-significant heritabilities were obtained for the trait SERVES in all analyses. For the across breed analysis the heritability of SERVES was found to be 0.09±0.09.

Keywords: Heritability, libido, mounts, serves, cattle.

INTRODUCTION

Reproductive efficiency in a beef herd is highly important to the beef producer (Coulter and Kozub 1989) and is a major limitation to enterprise profitability in Northern Australia where weaning rates may be as low as 45-60% (O'Rourke *et al.* 1995; Sullivan *et al.* 1997). MOUNTS+SERVES have been demonstrated to influence calf output in multiple-sire matings in Northern Australia (Holroyd *et al.* 1998).

Traits associated with fertility are notoriously difficult to improve using phenotypic selection. The use of estimated breeding values has been shown to offer hope for improvement of such traits in other species, such as pigs (Hermesch *et al.* 1997). However, the sex-limited nature of reproductive traits, their low variation and their difficulty of measurement all hinder producer-driven genetic improvement. Before reproductive traits can be included in analyses to calculate estimated breeding values, some knowledge of genetic parameters associated with the traits is required. One earlier study of bull serving capacity reported high heritability for libido (Blockey *et al.* 1978) using Angus and Hereford bulls. The current work aims to estimate heritabilities and genetic variances for traits associated with libido using components of mating behaviour as the indicator in three breeds commonly used in the sub-tropics. One of the breeds analysed (Hereford) has been included in prior analyses by other researchers (Blockey *et al.* 1978; Meyer *et al.* 1990; Meyer *et al.* 1991; Morris *et al.* 1992).

MATERIALS AND METHODS

Measurements were made available from 648 beef bulls between two and four years old belonging to six beef cattle stud properties located in Queensland between 1992 and 1997. Breeds represented in the data included Santa Gertrudis (251), Belmont Red (208) and Hereford (189). Two traits associated with bull libido (MOUNTS and SERVES) were measured using a serving capacity test as described by Bertram (1999). The test involved exposing small groups of bulls (2-6) that had prior visual stimulation to a similar number of restrained females (not in oestrus) for a twenty-minute period. To be recorded as a MOUNT, a complete normal mount, with or without intromission but without ejaculation was required. A SERVE was counted as a successful mount with ejaculation. For bulls subjected to repeated tests, the best (highest) test result was used in this analysis since this was thought to best represent the animal's phenotypic potential for the traits.

Other data available for the bulls included date of birth, weight at time of test, and sire. Field collection of data was performed in early spring of each year before spring bull sales. Staff of the Queensland Department of Primary Industries and The University of Queensland collected the data. Ethical clearance was obtained.

Analyses were carried out using ASREML (Gilmour *et al.* 1999). The animal model fitted to analyse the traits across breeds included year of test and property of origin as a single fixed effect (Property-Year combination) with age and weight at test fitted as quadratic covariables for those breeds with the data. Breed and property of origin were confounded in the data.

Table 1. Heritability of MOUNTS

Breed(s)	Model [a]	Heritability (h^2)	σ^2_{Sire}	σ^2_{Sire} /SE [b]	$\sigma^2_{Within\text{-}sire}$ [c]
ALL BREEDS	**P-Y S**	**0.29±0.14**	**1.18**	**2.01**	**15.11**
	P-Y A S	0.28±0.14	1.15	1.97	15.14
	P-Y A A^2 S	0.29±0.14	1.16	1.97	15.14
SANTA GERTRUDIS	**S**	**0.57±0.25**	**2.49**	**2.05**	**15.06**
	P-Y A S	0.53±0.28	2.29	1.87	15.09
	P-Y A A^2 S	0.53±0.26	2.30	1.87	15.11
HEREFORD	S	0.00±0.00	0.00	0.00 (B)[d]	10.87
	A S	0.00±0.00	0.00	0.00 (B)	10.61
	A A^2 S	**0.00±0.00**	**0.00**	**0.00 (B)**	**10.54**
BELMONT RED	**S**	**0.13±0.18**	**0.71**	**0.72**	**20.51**
	A S	0.11±0.19	0.59	0.59	20.59
	A A^2 S	0.11±0.19	0.58	0.58	20.69

[a] P-Y, A, A^2 , S: Property-Year combination (Fixed), Age (Covariate), Age (Quadratic covariate), and Sire (Random) respectively.
[b] Sire variance component significant when σ^2_{Sire} /SE >=2, Not significant when σ^2_{Sire} /SE <1 (Gilmour *et al.* 1999) . SE is the component standard error (as estimated from the Average Information Matrix).
[c] Model optimised when within-sire mean square and therefore the within-sire variance component is minimised. Shown in bold type.
[d] Fixed at baseline.

Table 2. Heritability of SERVES

Breed(s)	Model [a]	Heritability (h^2)	σ^2_{Sire}	σ^2_{Sire} /SE [b]	$\sigma^2_{Within\text{-}sire}$ [c]
ALL BREEDS	P-Y S	0.63±0.18	0.46	3.12	2.49
	P-Y A S	0.29±0.13	0.18	2.07	2.35
	P-Y A A^2 S	**0.09±0.09**	**0.05**	**1.02**	**2.20**
SANTA GERTRUDIS	P-Y S	0.37±0.23	0.16	1.51	1.61
	P-Y A S	**0.39±0.23**	**0.17**	**1.61**	**1.52**
	P-Y A A^2 S	0.28±0.21	0.12	1.33	1.58
HEREFORD	S	0.18±0.21	0.19	0.83	3.81
	A S	0.46±0.34	0.47	1.25	3.63
	A A^2 S	**0.36±0.30**	**0.34**	**1.12**	**3.48**
BELMONT RED	S	0.69±0.23	0.63	2.08	3.02
	A S	0.01±0.16	0.01	0.05	2.09
	A A^2 S	**0.00±0.00**	**0.00**	**0.00 (B)[d]**	**1.85**

[a] P-Y, A, A^2 , S: Property-Year combination (Fixed), Age (Covariate), Age (Quadratic covariate), and Sire (Random) respectively.
[b] Sire variance component significant when σ^2_{Sire} /SE >=2, Not significant when σ^2_{Sire} /SE <1 (Gilmour et al. 1999) . SE is the component standard error (as estimated from the Average Information Matrix).
[c] Model optimised when within-sire mean square and therefore the within-sire variance component is minimised. Shown in bold type.
[d] Fixed at baseline.

Within-breed analyses were also carried out fitting the same variables. The heritability was only presumed to be significant when the ratio of the sire component of variance to the standard error was greater than two and this event coincided with the model that minimised the within-sire variance component.

RESULTS

Not all bulls had all data available. The most complete data were available on the Santa Gertrudis breed. The number of MOUNTS recorded per bull ranged between zero and 25. The number of SERVES ranged between zero and 12. The distributions were approximately normal with some loading in the zero category.

The results (Tables 1-2) show that heritabilities of serving capacity traits have high standard errors. Heritabilities significantly different from zero were found for the All Breeds analysis of MOUNTS fitting Property-Year and Sire (0.29±0.14) and the Santa Gertrudis analysis of MOUNTS fitting sire only (0.57±0.25). No significant heritability was observed for the trait SERVES. This may have been due to the high number of zero records for this trait. Values for the sire component of variance in the Hereford MOUNTS analysis were fixed at the boundary and not estimable.

DISCUSSION

The skewed distribution is not surprising given that 'zero' is the base threshold value and that little or no selection for these traits has been applied to the herds. The range in number of serves is similar to that reported for several *Bos taurus* breeds by Bertram (1992). The deficiency of information from dams and other relatives reduced the power of the genetic analysis. Generally fitting either weight or age in the model improved the model. Animals of the Belmont Red breed were generally younger than those of other breeds. This may have increased the level of phenotypic variation in MOUNTS and SERVES in that breed. Success rate in serving capacity has been shown to increase with age, with the number of mounts decreasing and the number of serves increasing as animals age (Bertram 1999). The lack of estimable heritabilities for Hereford cattle made a comparison between the tropical and temperate breeds impossible.

The estimates that are most appropriate for the trait MOUNTS are 0.29±0.14 for the across breed comparison, and 0.57±0.25 for Santa Gertrudis. Results for this trait were non-significant or non-estimable for the Hereford and Belmont Red groups. For the trait SERVES, fitting age as a covariable minimised the within-sire component of variance, but also removed the effect and significance of the sire component suggesting that the significance of the sire component may have been due to age grouping effects. The best models for this trait suggest a non-significant heritability for the across breed and within-breed analyses.

The results demonstrate that the trait MOUNTS is heritable and that selection for this trait may lead to an increase in the willingness or ability of sires to mount. The trait SERVES was not demonstrated to be heritable in this study and so improvement is not expected if selection is based on this trait.

REFERENCES

Bertram, J.D. (1992) Serving Capacity Testing. In "Bull Fertility" (R.G.Holroyd Ed.) Workshop Proceedings, Rockhampton, 8 September 1992. Queensland Department of Primary Industries, Brisbane Qld. 26.

Bertram, J.D. (1999) Structural and behavioural characteristics of reproductive performance in tropically adapted bulls. Master of Rural Science thesis. University of New England. 1999.

Blockey, M.A.deB, Straw, W.M. and Jones, L.P. (1978) *J. Anim. Sci.* **47 Supp 1**: 253.

Coulter, G.H. and Kozub, G.C. (1989) *J. Anim. Sci.* **67**: 1757.

Gilmour, A.R., Cullis, B. R., Welham, S. J. and Thompson, R. (1999) NSW Agriculture Biometric Bulletin No. 3 ASREML Reference Manual. The State of New South Wales. NSW Agriculture, 1999.

Hermesch, S., Graser, H.U. and Mingay, M. (1997) *Proc. Assoc. Advmt Anim. Breed. Genet.* **12**: 317.

Holroyd, R.G., Doogan, VJ, DeFaveri, J., Fordyce, G., McGowan, M.R., Bertram, J.D., Vankan, D.M., Fitzpatrick, L. A., Jayawardhana, G.A., Miller, R. G. (1998) *XX World Buiatrics Congr.* **1**: 6 July 1998. Sydney.

Meyer , K., Hammond, K. Parnell, P.F., Mackinnon, M. J. and Sivarajasingham, S. (1990) *Livest. Prod. Sci.* **25**: 15.

Meyer,K. Hammond, K., Mackinnon, M.J. and Parnell, P.F. (1991) *Proc. Assoc. Advmt Anim. Breed. Genet* **9**: 251.

Morris, C.A., Baker, R.L. and Cullen, N.G. (1992) *New Zeal. J. Agric. Res.***35**: 195.

O'Rourke, P.K., Fordyce, G., Holroyd, R.G. and Sullivan, R.M. (1995). *Aust. J. Exp. Agric.***35**: 307.

Sullivan, R.M., O'Rourke, P.K, and Neale, J.A. (1997) *Aust. J. Exp. Agric.* **37**: 287.